received 02/20/02

07YX

4.1 INTRODUCTION

4.1.1 Background

The purpose of this Risk Assessment Workplan is to establish the sampling strategy, exposure assumptions, and the procedures and protocols to be followed for performing a Human Health Risk Assessment (HHRA) at the St. Louis Army Ammunition Plant (SLAAP). The risk assessment will be performed to support transfer of the property consistent with the Finding of Suitability to Transfer (FOST) process. The methodologies, technical approaches and assumptions outlined in this risk assessment workplan are consistent with guidelines established by the EPA in *Risk Assessment Guidance for Superfund* (RAGS) (1989a) and the Missouri Department of Natural Resources in Cleanup Levels for Missouri (CALM) (MDNR, 1998).

4.1.2 Site Description

The SLAAP property is an approximately 21-acre site that is located in an urban, mixed-use (commercial, industrial and residential) neighborhood adjacent to Interstate 70 in St. Louis, Missouri. The site is bounded on the north by Interstate 70, on the west by Goodfellow Boulevard, on the south by the PURO Chemical Division (PURO) and the east by Riverview Boulevard. The site is currently vacated. The SLAAP property contains eight unoccupied buildings. Except for small grassy areas, buildings and asphalt cover the SLAAP property. A railroad spur that once served the former Building 202 ABC (now Building 3) remains near the middle of the property. A security fence encompasses the site.

No surface water is present on the SLAAP property. Storm water on the property is collected by catch basins that discharge to the Metropolitan St. Louis Sewer District combined sewer system. Groundwater is not used at the site. Additionally, groundwater is not used as a drinking water source in the City of St. Louis.

4.1.3 Site History (NOTE TO REVIEWER..this section is redundant to the SAP, and will not be included in the final document..)

The St. Louis Ordnance Plant (SLOP) was constructed in 1941. SLOP was a 276-acre, small arms ordnance plant that produced 0.30- and 0.50-caliber munitions. In 1944, 21.05 acres in the northeast portion of SLOP, along with additionally acquired land on the north, were converted from small arms ammunition production to 105-millimeter (mm) Howitzer shell production and this portion was designated as SLAAP. After World War II, SLAAP was placed on standby status. It was reactivated from November 1951 to December 1954 and again from November 1966 to December 1969 to support 105-mm Howitzer shell production.

In 1984, several buildings at SLAAP were renovated to house filing and administrative operations by more than 500 personnel from the U.S. Army Aviation Systems Command (AVSCOM). In 1989, the Department of the Army determined that SLAAP was no longer required to support its munitions mission, and most industrial equipment was removed from the plant. In 1990, plant ownership and control were placed under the U.S. Army Aviation and Troop Command (ATCOM). As of 1993, SLAAP maintenance and surveillance activities were being subcontracted by Donovan Construction Company to Plant Facilities and Engineering, *Inc. (PFE). Since 1998, SLAAP has been vacant and under the control of AMCOM. Currently, the SLAAP property contains eight unoccupied buildings that were used to house the SLAAP main operating processes. Some work has been performed inside building three to remediate PCB contamination in building related materials to address a Notice of Non-compliance issued by the EPA.*

A variety of manufacturing and maintenance related processes might have contributed to contamination at the site. A record search and initial site visit were conducted as part of a comprehensive Environmental Baseline Survey (EBS) to identify possible areas of environmental concern at SLAAP. The following are the primary areas of possible environmental concern that were identified through the records reviewed and the initial site visit:

- *Electrical and hydraulic equipment used at the site are suspected of containing PCB contaminated oils.*
- *PCBs may have been present in cutting oils used during milling processes at the site.*
- *Metals contamination may be present based upon the milling and forging processes that occurred at the site.*
- *Several of the buildings contain emergency power supply units that may contain lead-acid or nickel-cadmium batteries.*
- *Several aboveground and underground storage tanks were once present at the site.*
- *Possible chromium contamination is suspected due to a cooling tower that was once present on the site.*
- *Several of the buildings have possible asbestos containing materials.*
- *Several of the buildings are suspected of containing lead-based paint.*

4.2 SELECTION OF CHEMICALS OF POTENTIAL CONCERN (COPCS)

The first step in the risk assessment process is the identification of the Chemicals of Potential Concern (COPCs) to be considered for the estimation of potential risks. The COPCs are a subset of all of the chemicals detected at the site. The COPCs represent those chemicals that have the greatest potential to pose risks for the site. By careful screening of site data, the risk assessment can limit the chemicals undergoing a full evaluation without underestimating overall site risks.

Site-related risks will be determined on an area-by-area basis. Because of this, COPCs may differ from one area to another. The rationale for determining these exposure areas will be detailed further in the exposure assessment section.

COPCs will be determined on a medium specific basis. Media that may pose a potential risk at the site include soil, groundwater and building related materials. These are described in greater detail in the exposure assessment section (below).

For purposes of evaluating potential exposure to surface and subsurface soils by different receptor populations, soil COPCs will be separated into several groups. Calculations involving potential exposures to surface soils will be based on soil analytical data taken from 0 to 2 feet beneath ground surface (ft bgs). Because the deepest trench that a future worker would reasonably be expected to dig on-site for utility or construction work is about 10 ft bgs, calculations involving direct exposure to soil by future workers during intrusive activities (i.e., excavation) will be based on soil analytical data taken from 0 to 10 ft bgs.

The only potential direct exposure to groundwater is if an excavation/construction worker were to trench into areas containing shallow groundwater (<10 ft bgs). Any chemicals found in shallow groundwater above the groundwater screening values (Region IX PRGs or MDNR CALM Scenario A values, as described below) will be retained as COPCs for the purpose of evaluating direct exposure. In addition to direct contact, there is the potential for inhalation of VOCs released from groundwater. This could include areas where the depth to groundwater is greater than the depth of excavation (i.e., >10 ft bgs). Any VOCs found to be present in the uppermost groundwater unit at concentrations exceeding their respective screening concentrations will be retained as COPCs, even if this groundwater is located greater than 10 ft bgs. For this risk assessment, a volatile contaminant will be defined as a contaminant having both a molecular weight less than 200 and a Henry's Law Constant greater than 10^{-5} (EPA, 1991a).

Previous sampling events have indicated the presence of a limited number of constituents in soil, groundwater and building related materials at the site. Since these studies have indicated the absence of several classes of compounds in some areas, a full suite analysis for VOCs, SVOCs, metals, explosives and PCBs is not warranted for all portions of the site. Analytical methods will be determined on an area-by-area basis. The rationale for the choice of analytical methods at each area is documented in Section 3.0.

COPCs will be selected for each area/medium/exposure pathway by comparing the relevant analytical data to EPA Region IX Residential Preliminary Remediation Goals (PRGs) and MDNR CALM Scenario A levels (which are based on residential exposures). Any constituent with a detected value in exceedance of either screening value will be selected as a COPC for the relevant pathway or pathways. Chemicals with no detected concentrations will not be considered COPCs for an exposure area/pathway.

Some compounds may be present at the site, in exceedance of the screening criteria, due to naturally occurring background conditions. These may include metals and essential nutrients present in soil throughout the entire geological area surrounding the site. Along the rail line, these may include the same metals and essential nutrients along with SVOCs associated with normal railroad operations (i.e., railroad tie preservatives and diesel constituents from the engines), that may be unrelated to site impacts. Since the risk assessment is interested in determining only risks resulting from site-related impacts, metals and essential nutrients will not be selected as COPCs unless they exceed background concentrations for the area surrounding the site. Compounds whose maximum detected concentration in an area exceeds the 95th upper tolerance limit (UTL) for the background concentrations and the previously mentioned EPA and MDNR criteria will be selected as COPCs for that area. The choice of suitable background locations (one for metals and essential nutrients, another for railroad-related activities) is described more thoroughly in Section 3.2.

4.3 EXPOSURE ASSESSMENT

The purpose of the exposure assessment is to estimate the magnitude of potential chemical exposure among various receptor populations. The steps required to perform an exposure assessment include the following:

- Identification of potential receptor populations and exposure scenarios
- Evaluation of potential exposure pathways for completeness
- Evaluation of potential exposure parameters
- Estimation of exposure point concentrations

The approach to be used in this HHRA will incorporate conservative exposure assumptions when estimating the magnitude of potential exposures, so that potential risks posed by the Site are not underestimated. At the same time, exposure scenarios which are considered unlikely will be excluded, since they do not reflect realistic exposure conditions.

4.3.1 Evaluation of Potential Exposure

An important activity in the initial planning phase is the review of existing data and the development of a site conceptual exposure model. Information (including previous investigations) concerning waste sources, waste constituent release and transport mechanisms, and locations of potentially exposed individuals (receptors) is used to develop a conceptual understanding of the site in terms of potential human and ecological exposure pathways.

The site conceptual exposure model is a schematic representation of the potential contaminant source areas, chemical release mechanisms, environmental transport media, potential intake routes and pathways, and potential human or ecological receptors. The site conceptual exposure model presented in this SAP is based on conservative/worst-case assumptions about current and anticipated future site use associated with closure and subsequent reuse of the facility. The site conceptual exposure model has three primary purposes:

- to assist in the development of the sampling plan (i.e., sampling locations, media to be sampled, and chemicals to be sampled) so that information regarding potential human health and environmental impacts from the site can be collected efficiently;
- to create a framework for the risk assessment; and,
- to use as an aid in identifying effective cleanup measures, if necessary, that are targeted at significant contaminant sources and exposure pathways.

An exposure pathway includes four necessary elements:

- a chemical source and a mechanism of chemical release;
- an environmental transport medium (air, surface water, etc.);
- an exposure point; and,
- an intake route (inhalation, ingestion, dermal contact).

Each of these four elements must be present for an exposure pathway to be complete. Exposure pathways are considered to be complete if there are potential chemical releases and transport mechanisms and identified receptors for that exposure pathway. An incomplete pathway means that one of these elements is missing and hence, exposure cannot occur. Only potentially complete pathways will be addressed in the risk assessment.

In the site conceptual exposure model, **Figure 4-1**, potentially complete and significant exposure pathways are indicated with solid lines. Exposure scenarios are developed based on current uses of the site, as well as potential future uses. Given that the site is not an active facility at this time, and that access is controlled by security fencing, current exposure is likely to be restricted to occasional site visitors and trespassers. The most likely future property use at SLAAP is assumed to be industrial[1]. Excavation work associated with future building construction, utility maintenance, etc. is likely. Residential development is considered to be unlikely for all portions of the site for the foreseeable future, however, because many of the properties surrounding the site are residential, and because AMCOM wishes to be able to transfer the property without restriction, this hypothetical future land use will not be excluded.

Given the current and anticipated future use of the facility, the following receptor populations will be evaluated in the HHRA:

- Current trespassers/site visitors. Currently, most areas of the site are covered by buildings or paved. Trespassers/visitors could contact contaminated soils around the periphery of the property in areas of exposed surface soil. Exposure could occur via direct dermal contact or incidental ingestion of soil, or inhalation of dust. The inhalation exposure route is considered insignificant relative to the other two routes, since exposed soils are vegetated and thus unlikely to generate substantial amounts of dust. The HHRA will quantitatively evaluate direct dermal contact and incidental ingestion of exposed surface soils by current trespassers/visitors. A future trespasser/visitor scenario will not be quantitatively evaluated in the HHRA, since more conservative (e.g., health-protective) future use scenarios are being evaluated.

  In addition to soil exposure, trespassers could also be exposed to contaminants in buildings at SLAAP. As described below, building exposures cannot be adequately addressed using EPA's risk assessment process as described in RAGS (EPA, 1989a), and thus will not be quantitatively evaluated in the HHRA.

- Future industrial/commercial workers. Given that the most likely future use of the site is as a commercial/industrial facility, the future worker scenario is considered the most realistic future use scenario for the facility. In contrast to the trespasser, exposure by workers could occur anywhere on site, including areas that are currently paved or covered with buildings, since it is likely that some or all of the buildings currently on-site will be removed in the future. For purposes of the HHRA, workers could be considered anybody who works at the site on a daily basis for an extended period of time (years). Industrial/commercial workers could be exposed to surface soils via direct dermal contact, incidental ingestion, and inhalation. As was true for the trespasser, inhalation of dust is considered minor/insignificant, and will not be evaluated quantitatively.

- Future excavation/construction workers. Construction workers, utility workers, and other excavation workers could be exposed to both surface and subsurface contamination during any type of excavation work. Exposure could occur from direct dermal contact and incidental ingestion of soils or groundwater (if the groundwater is present at depths less than 10 ft bgs), as well as inhalation of volatile organic compounds (VOCs) released from these

[1] A review of local zoning ordinances and other relevant city planning documents will be performed in support of the HHRA.

soils or from the underlying groundwater. For purposes of the HHRA, excavation work will be evaluated for soils ranging from 0-10 ft bgs, consistent with the deepest routine depth anticipated for utility lines.

- Hypothetical future residents. Although residential use of the property is unlikely, a hypothetical resident will be evaluated for potential exposure to surface soil, using the same exposure routes (direct dermal contact and incidental ingestion) as used for the industrial/commercial worker. Groundwater exposure is not considered likely, since it is illegal to construct a domestic supply well within the city of St. Louis. Residential scenarios are generally considered the most conservative scenarios evaluated in a HHRA, thus the inclusion of this scenario in the SLAAP HHRA should provide a conservative (health-protective) estimate of potential risks for other populations that may be present on-site but that are not evaluated quantitatively.

While these four exposure scenarios do not represent every potential receptor population that could conceivably exist at SLAAP, they are considered conservative enough to provide a protective evaluation for any other reasonably anticipated site population.

It should be noted that the HHRA specifically will not provide a quantitative evaluation for the following:

- Ecological risks
- Risks associated with current buildings

Ecological risks are assumed to be negligible. The only areas of exposed soils offer minimal habitat of poor quality (i.e., mowed lot), and there are no surface water bodies impacted by site contamination. A brief discussion on ecological exposure issues, as described above, will be included in the HHRA.

Several buildings currently on-site are likely to contain some level of contamination. Current risk assessment protocols cannot accurately estimate risks associated with chemicals on walls and floors of buildings. The potential acceptability of contamination in the buildings will be evaluated based on comparisons to standards (discussed in Section 3.2), in conjunction with exposure control actions. From a risk perspective, it should be noted that the buildings are not occupied at this time, nor are they likely to be occupied in the future without requiring substantial renovation first. Such renovation (e.g., painting, wall partitions, new flooring, active ventilation system, etc.) would undoubtedly reduce or eliminate potential exposure. A discussion of potential human exposure to contaminated buildings, as described above, will be included in the HHRA.

4.3.2 Exposure Areas

At the present time a number of buildings are present at SLAAP. While it is likely that several of these buildings will be demolished prior to reoccupation of the site, the final determination of which buildings are demolished and which remain has not been made. Only the fate of Building 3 is currently known since AMCOM will require the buyer of the property to demolish it after property transfer. In order to provide maximum flexibility in site risk management decision-making, the site will be subdivided into a number of "exposure areas" for evaluation in the HHRA. Soils underlying each individual building will be treated as individual exposure areas.

In the event a building were demolished, this would provide the information necessary to address the newly exposed soils. This approach also addresses the fact that different industrial activities occurred in different buildings, and that different chemicals and chemical concentrations are found in different buildings. In addition to the building "footprints", areas surrounding the buildings (parking areas, roadways, rail spurs, etc.) will also be treated as individual exposure areas. A summary of all individual exposure areas to be evaluated in the HHRA is presented in Section 3.2 and shown on **Figure 3-11**.

4.3.3 Exposure Assumptions

In order to calculate the chronic daily intake of site contaminants and to estimate the associated potential health risks, a number of exposure parameters must first be quantified. The exposure parameter values to be used in this risk assessment have been selected from the Exposure Factors Handbook (EPA, 1997a, 1989b), OSWER Directive 9285.6-03 (Standard Default Exposure Factors; EPA, 1991b), RAGS (EPA, 1989a), Peer Review Draft Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites (EPA, 2001) and through the use of professional judgement.

Exposure will be evaluated for both RME and CTE exposure. The RME is an estimate of the maximum exposure that can reasonably be expected to occur. The CTE represents a more typical exposure for the average individual. The exposure parameters to be incorporated into the risk calculations are listed in **Table 4-1** and described in the following paragraphs.

<u>Averaging Time</u>: The assumed lifespan, used as the averaging time for evaluating carcinogens, as given in the OSWER Directive 9285.6-03 (EPA, 1991b), is 70 years (25,550 days) for all receptors.

The averaging time used for evaluating non-carcinogens is based on the duration and frequency of exposure. For exposure pathways with exposure durations of more than one year, the averaging time for non-carcinogens is calculated by multiplying the exposure duration times 365 days/year. For the future excavation/construction worker pathway, which has an exposure duration of less than one year, the averaging time for non-carcinogens is an estimate of the total number of days that the construction activity would take to complete (including weekends and holidays). An estimate of 42 days will be used for CTE and 84 days for RME.

<u>Exposure Duration</u>: Exposure duration refers to the number of years in which exposure occurs. On-site workers are assumed to have an RME duration of 25 years as given in OSWER Directive 9285.6-03 (EPA, 1991b). A CTE exposure duration of 5 years is assumed, based on information supplied by the Bureau of Labor Statistics (U.S. Department of Labor, 1992) showing 5 years to be the average time an individual spends at one job.

For a hypothetical future resident, the RME exposure duration is assumed to be 30 years, which is the 90th percentile for an individual living in a single residence (EPA, 1989b). Nine years, which is the 50th percentile for an individual living at a single residence, will be used to evaluate the CTE scenario. These same exposure durations will be used to evaluate the trespasser scenario, based on the assumption that a trespasser could be a local resident.

Utility installation or building construction is considered the most likely future site-specific excavation activity. This type of activity generally occurs over a relatively short duration.

Based on professional judgment, this activity is estimated to be completed within one construction season for both the RME and the CTE scenarios.

Exposure frequency: Exposure frequency refers to the total number of days per year spent at the site.

On-site workers will be assumed to spend 250 days per year on-site for both RME and CTE exposure, based on a 5-day working week for 50 weeks per year (OSWER Directive 9285.6-03; EPA, 1991b).

Excavation/construction workers will be assumed to have an exposure frequency of 60 days (12 workweeks) and 30 days (6 workweeks) for RME and CTE exposure, respectively. This is based on professional judgement regarding the number of workdays subsurface construction would take to complete.

Because of the location of the site and the limited size of the evaluated exposure areas, trespassers will be assumed to visit the site on an infrequent basis. It is conservatively assumed that the trespasser will visit the area 12 days per year for RME and 6 days per year for CTE exposure.

Residents will be evaluated using the standard default assumption of 350 days per year for both the CTE and RME scenario (EPA, 1991b).

Incidental Soil Ingestion Rate: The incidental soil ingestion rate refers to the amount of soil that is ingested daily via incidental contact (e.g., hand-to-mouth contact). For RME exposure, Standard Default Exposure Factors (EPA, 1991b) recommends soil ingestion rates of 50 mg/day for worker populations. The incidental ingestion rate for industrial workers of 50 mg/day is also the value recommended by EPA (1997a) for all adults. This value will be applied to the assessment of an on-site worker scenario. For calculations of CTE exposure, a value of 25 mg/day will be used. These exposure estimations will also be applied to the site trespasser scenario.

Since soil excavation activity may involve increased exposure to soil, 200 mg/day was used as the RME soil ingestion rate for construction workers. This RME value is four times the RME value recommended by EPA (1997a) for evaluation of worker exposure. For calculations of construction worker central tendency exposure, a value of 100 mg/day will be used. This is the CTE ingestion rate for construction work recommended by EPA's Technical Review Workgroup for lead.

For RME residential exposure scenarios, EPA recommends the use of soil ingestion rates of 100 mg/day for individuals over the age of 6 years, and 200 mg/day for 0- to 6-year old children (EPA, 1991b). CTE soil ingestion rates will be assumed to be one-half the RME rate (i.e., 50 mg/day for individuals over the age of 6 years, and 100 mg/day for 0- to 6-year old children).

Incidental Groundwater Ingestion Rate: The incidental groundwater ingestion rate refers to the amount of groundwater that is ingested daily via incidental contact (e.g., hand-to-mouth contact). Based on professional judgement, a RME value of 2 ml/day will be used as the incidental groundwater ingestion rate for excavation activity. A value of one half of the RME rate, 1 ml/day, will be used for CTE exposure.

Body Weight: The body weight for an adult was obtained from OSWER Directive 9285.6-03 (EPA, 1991b). The assumed body weight for adults is 70 kg. This value will be used for on-site workers, excavation/construction workers, adult residents and trespassers. For 0-6 year old child residents, a time-weighted average body weight of 15 kg will be used (EPA, 1991b).

Area of Exposed Skin: Exposed skin surface area is important when evaluating uptake of constituents that are absorbed dermally. For dermal exposure to soil, an RME surface area of 3,300 cm^2 will be used to evaluate potential adult receptor scenarios (hypothetical on-site workers, excavation/construction workers, trespassers, and adult residents), and 1913 cm^2 for the child resident, based on the surface areas of face, forearms, and hands (EPA, 1997a). For central tendency exposure the total exposed surface area, assumed to be limited to the head and hands, is 2,000 cm^2 for adults and 1440 cm^2 for children (EPA, 1997a). The same adult skin surface areas will be used when evaluating potential exposure of excavation/construction workers to shallow groundwater.

Dermal Soil Adherence: Dermal soil adherence is used, in conjunction with exposed skin surface area, to define the total amount of soil adhering to exposed skin surfaces. For the excavation/construction worker scenario, an adherence rate of 0.2 mg/cm^2 will be used. For site workers, an adherence rate of 0.03 mg/cm^2 will be used, based on the reported mean soil adherence of soil to hands, head and arms for groundskeepers (EPA, 1997a).

For trespassers and residents, RME and CTE adherence rates were taken from the Exposure Factors Handbook. An adherence rate of 0.025 mg/cm^2 will be used for both RME and CTE, based on the reported mean soil adherence of soil to hands, head and arms for a soccer players (EPA, 1997a). (Note: Soil adherence rates for residents/trespassers per se are not presented in the Exposure Factors Handbook. Soccer players were chosen as a surrogate for trespassers and residents because they represent an outdoor activity with relatively high soil contact by youths).

Dermal Soil Absorption Rate: Dermal soil absorption values, used to estimate constituent absorption through the skin, are chemical class-specific values. Region IV EPA (1998) absorption rates of 0.1 percent for inorganics and 1.0 % for organics will be used to evaluate dermal absorption..

Permeability Constant: The permeability constant is used when evaluating uptake of chemicals that are absorbed dermally from aqueous media. Chemical specific permeability constants, as reported in Dermal Exposure Assessment: Principles and Applications (EPA, 1992a), will be used to estimate dermal absorption of constituents from water. For chemicals without chemical-specific values, the generic permeability constant for water (0.001 cm/hour) will be used.

Exposure Time: Exposure time, used to evaluate inhalation by an excavation/construction worker, refers to the number of hours per day in which the exposure occurs. A standard workday is eight hours long. The RME exposure time for the future excavation/construction worker of 4 hours per day assumes that half of that time is spent actually working in the trench. A CTE exposure duration of 2 hours per day will be assumed, also based on professional judgement.

Inhalation Rate: The inhalation rate is used to estimate the volume of trench air that an excavation/construction worker might breath while working in a trench. Inhalation rates were taken from the Exposure Factors Handbook (EPA, 1997a). An inhalation rate of 2.05 m^3/hour, based on the assumption that half of the time spent working in a trench would involve moderate activity levels and half heavy activity levels, will be used to evaluate the RME scenario. For the CTE scenario, a rate of 1.3 m^3/hour will be used, based on the assumption that half of the time spent working in a trench would involve light activity levels and half moderate activity levels.

4.3.4 Exposure Point Concentrations

Exposure Point Concentrations are the chemical concentrations to which a receptor is exposed when contact is made with a specific environmental medium. As specified in Section 3.2, site data for each exposure area are being collected using two different approaches. For evaluating representative risks for each exposure area, soil samples will be collected using a systematic sampling grid. In addition, separate "hotspot" risk evaluations will be performed for any hotspots identified in each exposure area, using the site characterization data that were collected using a biased sampling approach. The purpose of this two-tiered evaluation is to provide site risk managers with sufficient risk information to support hotspot removal, if warranted, without providing a biased overview of overall risks for each exposure area.

The following paragraphs describe the calculation of exposure point concentrations for each media in which exposure may occur.

For chemicals displaying a lognormal distribution pattern, the 95% upper confidence limit of the mean (95% UCL) will be used to estimate exposure point concentrations for the COPCs (EPA, 1992b), using the equation shown below:

$$UCL = e^{(\bar{x}+0.5s^2+sH/\sqrt{n-1})}$$

Where:

UCL = upper confidence limit

e = base of the natural log (2.718)

x = mean of the log transformed data

s = standard deviation of the log transformed data

H = H statistic (obtained from statistics table)

n = number of samples

A surrogate concentration of ½ of the detection limit will be used for non-detected samples in the calculation of the 95% UCL.

The accuracy of the H-statistic relies on the assumption that the data set being analyzed is lognormally distributed. For sample data that are not lognormally distributed, the use of the H-statistic to estimate the 95% UCL can result in a 95% UCL value that is unrealistically large. Based on EPA guidance, a non-parametric statistical method for calculating the 95% UCL may be more appropriate for chemicals displaying a non-lognormal distribution (EPA, 1997b). These non-parametric methods include several bootstrap and jackknife methods. Depending on the nature/statistical distribution of the data collected at the site, a non-parametric method may be used to calculate exposure point concentrations if the H-statistic approach is deemed to be inappropriate.

The 95% UCL will not be calculated for data sets with only one detected concentration. For these constituents, the maximum detected concentration will be used as the exposure point concentration. In addition, the maximum detected concentration will be used as the exposure point concentration in cases where the 95% UCL exceeds the maximum detected concentration.

4.4 TOXICITY ASSESSMENT

Toxicological information for hazardous chemicals most often released to the environment from hazardous waste sites is generally well documented in the scientific literature. Chemicals that have documented EPA toxicity criteria (Reference Dose [RfD] for non-carcinogens and cancer slope factor [SF] for carcinogens) will be evaluated quantitatively in the risk assessment. Chemicals without such criteria will be evaluated qualitatively in terms of their potential contribution to risk. This risk assessment will follow the EPA recommended hierarchy of sources for determining critical toxicity criteria (RfDs and SFs). The first source in this hierarchy is IRIS (Integrated Risk Information System) and is the primary source of toxicological information for this risk assessment. The current Health Effects Assessment Summary Table (HEAST; EPA 1997c) will also be consulted for toxicity criteria where needed. In addition, pertinent literature may be reviewed in order to summarize individual chemical toxic properties relevant to site- and receptor-specific exposures.

4.5 RISK CHARACTERIZATION

Human health risks will be evaluated for long-term (chronic) exposures, and where appropriate, short-term (subchronic) exposures. The potential health risks from the various exposure routes (inhalation, ingestion, and dermal contact) to contaminated media will be included in the risk characterization.

The potential for non-carcinogenic human health effects is estimated by dividing the daily chemical intakes for each chemical by the respective RfDs. This evaluation is performed independently for each exposure pathway. The resulting ratios, termed hazard quotients, provide an estimate of the potential hazard associated with each chemical per pathway. Hazard quotients are summed for all chemicals within a pathway to provide an estimate of the pathway-specific hazard (termed the hazard index). The hazard index values for each pathway are subsequently summed to provide an estimate of the total hazard for each receptor. The generic equation used to calculate the hazard quotient is as follows:

Equation 1:

$$HQ = \frac{Cx * CR * EF * ED}{BW * ATnc} * \frac{1}{RfD}$$

Where:

HQ = Hazard Quotient (unitless)

Cx = Chemical concentration in contaminated medium (soil, groundwater, etc.)

CR = Contact Rate; the amount of contaminated medium contacted per unit time

EF = Exposure Frequency (days/year)

ED = Exposure Duration (years)

BW = Body Weight (kg)

ATnc = Averaging Time for non-carcinogens (days); equivalent to the period of exposure

RfD = Reference Dose (mg/kg-day)

Carcinogenic risks are calculated by multiplying the daily average lifetime intakes by the chemical-specific cancer slope factors, which results in an estimate of the excess lifetime probability of developing cancer from the exposure. As with hazard values, cancer risks are summed to provide pathway-specific and total risks. The generic equation used to calculate cancer risk is as follows:

Equation 2:

$$CR = \frac{Cx * CR * EF * ED}{BW * ATc} * SF$$

Where:

CR = Cancer Risk (unitless)

ATc = Averaging Time for carcinogens (days); equivalent to 70 year lifespan

SF = Slope Factor $(mg/kg\text{-}day)^{-1}$

4.6 UNCERTAINTY ANALYSIS

Conservative assumptions are used in the risk assessment to avoid underestimation of potential health risks, to address potential weaknesses in the data, and to enhance confidence in the results and conclusions. Nevertheless, uncertainties are inherent in the risk assessment process. The HHRA report will include a discussion of the major sources of uncertainty in the risk assessment and identify factors that may result in either overestimation or underestimation of potential risks and hazards.

4.7 REFERENCES

U.S. Department of Labor (USDL). 1992. Employee Tenure and Occupational Mobility in Early 1990's. USDL 92-386.

U.S. Environmental Protection Agency (EPA). 1989a. Risk Assessment Guidance for Superfund (RAGS), Volume I, Human Health Evaluation, Part A. Interim Final. EPA/540/1-89/002.

U.S. Environmental Protection Agency (EPA). 1989b. Exposure Factors Handbook. May.

U.S. Environmental Protection Agency (EPA). 1991a. Risk Assessment Guidance for Superfund: Volume 1 – Human Health Evaluation Manual (Part B, Development of Risk-based Preliminary Remediation Goals). December.

U.S. Environmental Protection Agency (EPA). 1991b. Standard Default Exposure Factors. OSWER Directive 9285.6-03. March.

U.S. Environmental Protection Agency (EPA). 1992a. Dermal Exposure Assessment: Principles and Application. Washington, D.C.

U.S. Environmental Protection Agency (EPA). 1992b. Supplemental Guidance to RAGS: Calculating the Concentration Term. OSWER Publication 9285.7-081.

U.S. Environmental Protection Agency (EPA). 1997a. Exposure Factors Handbook. August.

U.S. Environmental Protection Agency (EPA). 1997b. The Lognormal Distribution in Environmental Applications. December.

U.S. Environmental Protection Agency (EPA). 1997c. Health Effects Assessment Summary Tables, FY-1997 Update.

U.S. Environmental Protection Agency (EPA). 1998. Supplemental Guidance to RAGS: Region 4 Bulletins. Human Health Risk Assessment. Interim. January 16.

U.S. Environmental Protection Agency (EPA). 2001. Supplemental Guidance for Developing Soil Screening Levels for Superfund Sites. Peer Review Draft. OSWER 9355.4-24. March.

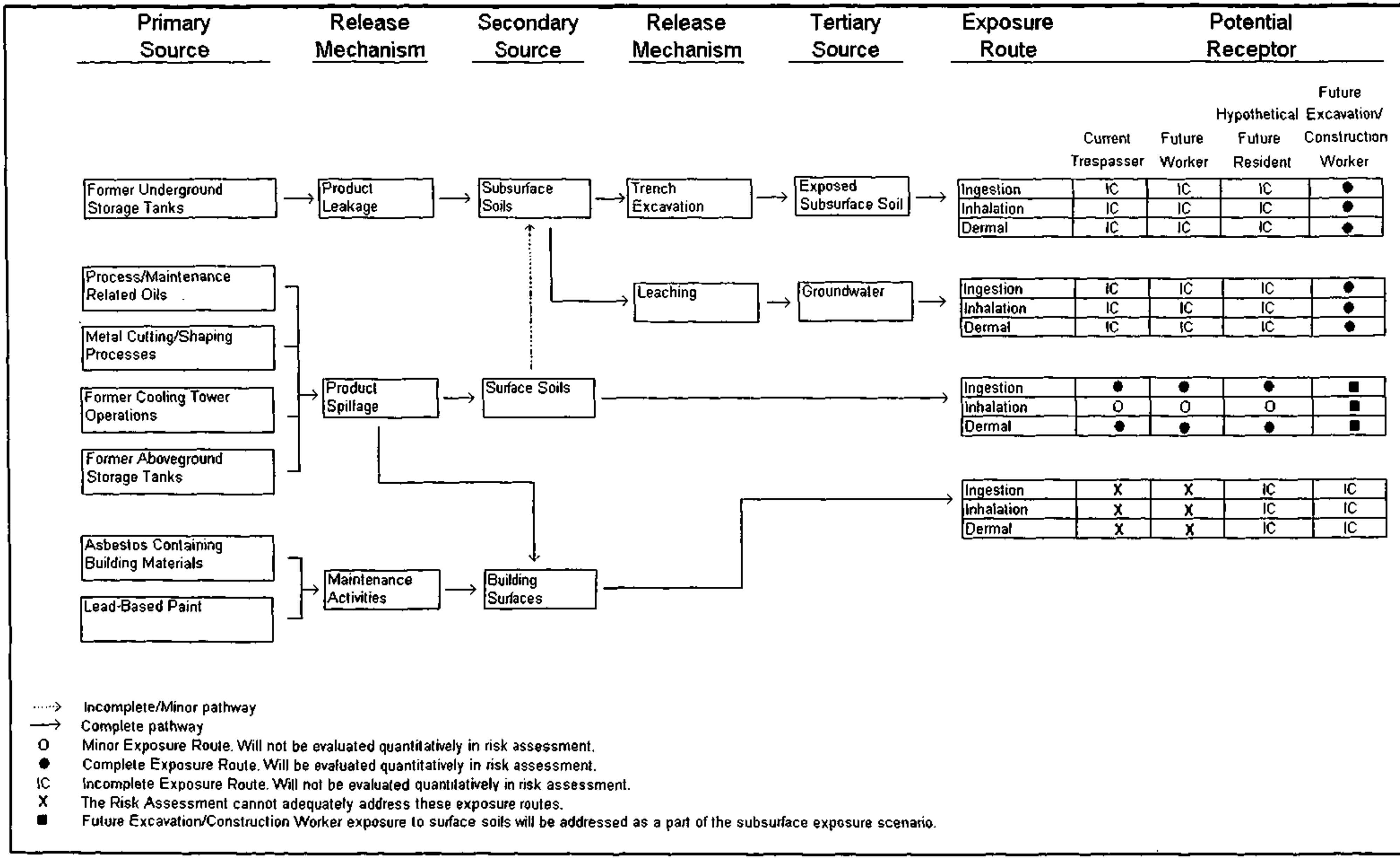
Table 4-1
Exposure Parameters
Human Health Risk Assessment
St. Louis Army Ammunition Plant (SLAAP)
St. Louis, Missouri

	Future Excavation/Construction Worker:		Future Worker:		Current Trespasser:		Hypothetical Future Resident:	
	CTE	RME	CTE	RME	CTE	RME	CTE	RME
Exposure Frequency (days/year)	30	60	250	250	6	12	350	350
Exposure Duration (years)	1	1	5	25	9	30	6/3[2]	9/21[2]
Incidental Soil Ingestion Rate (mg/day)	100	200	25	50	25	50	25	50
Incidental Groundwater Ingestion Rate (ml/day)	1	2	-	-	-	-	-	-
Body Weight (kg)	70	70	70	70	70	70	15/70[2]	15/70[2]
Averaging Time for Non-Carcinogens (days)	42	84	1,825	9,125	3,285	10,950	3,285	10,950
Averaging Time for Carcinogens (days)	25,550	25,550	25,550	25,550	25,550	25,550	25,550	25,550
Area of Exposed Skin (cm^2)	2,000	3,300	2,000	3,300	2,000	3,300	1440/2000[2]	1913/3300[2]
Exposure Time (hours/day)	4	8	-	-	-	-	8	8
Inhalation Rate (m^3/hour)	1.3	2.05	-	-	-	-	-	-
Permeability Constant (cm/hr)	chemical specific	chemical specific	-	-	-	-	-	-
Dermal Soil Adherence Factor (mg/cm^2)	0.12	0.12	0.03	0.03	0.025	0.025	0.025	0.025
Dermal Absorption Factor (unitless)	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]	chemical specific[1]

[1] 1% for organic compounds, 0.1% for inorganic compounds

[2] Future resident exposure will be based on a combined child adult exposure scenario.

Figure 4-1
Site Conceptual Exposure Model
St. Louis Army Ammunition Plant (SLAAP)
St. Louis Missouri



I:\K96219.01\Workplans\Comments\Site Conceptual Exposure Model.doc